ALBERTA OIL SANDS
ENVIRONMENTAL
RESEARCH PROGRAM

Wolf Population Dynamics and Prey Relationships in Northeastern Alberta

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Project LS 21.1.4
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ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

RESEARCH REPORTS

These research reports describe the results of investigations funded under the Alberta Oil Sands Environmental Research Program, which was established by agreement between the Governments of Alberta and Canada in February 1975 (amended September 1977). This 10-year program was designed to direct and co-ordinate research projects concerned with the environmental effects of development of the Athabasca Oil Sands in Alberta.

A list of research reports published to date is included at the end of this report.

Enquiries pertaining to the Canada-Alberta Agreement or other reports in the series should be directed to:

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Wolf Population Dynamics and Prey Relationships in Northeastern Alberta

Project LS 21.1.4

AOSERP Report 102

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The Hon. John W. (Jack) Cookson
Minister of the Environment
222 Legislative Building
Edmonton, Alberta

and

The Hon. John Roberts
Minister of the Environment
Environment Canada
Ottawa, Ontario

Sirs:

Enclosed is the report "Wolf Population Dynamics and Prey Relationships in Northeastern Alberta".

This report was prepared for the Alberta Oil Sands Environmental Research Program, through its Land System, under the Canada-Alberta Agreement of February 1975 (amended September 1977).

Respectfully,

W. Solodzuk, P.Eng.
Chairman, Steering Committee, AOSERP
Deputy Minister, Alberta Environment

A.H. Macpherson, Ph.D.
Member, Steering Committee, AOSERP
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WOLF POPULATION DYNAMICS AND PREY RELATIONSHIPS IN NORTHEASTERN ALBERTA

DESCRIPTIVE SUMMARY

The physical disturbances to the landscape and the additional human activity attending oil sands development are expected to have significant impacts on the population dynamics and ecology of big game species in the AOSERP study area. These populations constitute renewable natural resources having economic, social, recreational, aesthetic, and scientific values. Preservation and management of this big game resource require information on the natural control and regulation of populations, interaction with man, effects of disturbances from oil sands development on population dynamics, and detailed information about range preferences in the oil sands area of Alberta.

One aim of this research is to determine baseline information on the population dynamics and distribution and abundance of big game populations in the AOSERP study area. A second aim is to identify those environmental factors and intra- and interspecific interactions which have the greatest impact on distribution and abundance.

The specific objectives of the wolf study were to: (1) describe and quantify the baseline states of wolves in the oil sands area considering, at least, the following parameters: distribution of and number of animals in individual packs, sex and age ratios in individual packs, and recruitment and mortality rates; (2) describe and quantify interactions between wolves and moose with special reference to population regulation within individual packs; and (3) describe and quantify areas critical to wolves in the oil sands area (i.e., denning sites).

This report has been reviewed and accepted by the Alberta Oil Sands Environmental Research Program.

W.R. MacDonald, Ph.D.
Director (1980-81)
Alberta Oil Sands Environmental
Research Program

101-06762/

WOLF POPULATION DYNAMICS AND PREY RELATIONSHIPS IN NORTHEASTERN ALBERTA

by

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for

ALBERTA OIL SANDS

ENVIRONMENTAL RESEARCH PROGRAM

Project LS 21.1.4

August 1980

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ABSTRACT

Population studies of wolves (*Canis lupus*) were carried out between October 1975 and June 1978 on two study areas in northern Alberta. Ten adult wolves in four packs and two lone wolves were captured, radiocollared, and repeatedly located in the Alberta Oil Sands Environmental Research Program (AOSERP) study area; three wolves in two packs were radiocollared on the other area (Swan Hills). Telemetry data, observations of unmarked wolves, and trapper surveys indicated a winter wolf density of approximately 1/179 km^2, or 140 on the entire 25 000 km^2 AOSERP study area. Wolf density between areas varied with available food resources. Numbers appeared to have increased from 1975 to 1977 at a rate of about 21% annually. The wolf density of 1/77 km^2 on the Swan Hills study area appeared to be lower than in past years, and the population was probably expanding. Trapping and early pup deaths were likely the major mortality factors. Wolves killed or consumed disproportionately more young, old, and probably debilitated moose (*Alces alces*), as well as more female calves and adult bulls. Most wolf kills in winter (88%) were made in lowland habitats despite an even distribution of moose in uplands and lowlands. Deeper snow and colder temperatures in 1978 resulted in decreased daily travel (5.7 vs. 9.0 km/day) by one pack whose activities were intensively monitored on the AOSERP study area. The mean kill rate of this pack was the same in both years (1 moose/4.7 days); per capita consumption decreased slightly in 1978 (0.12 vs. 0.15 kg prey/kg wolf/day) due to larger mean pack size (9.8 vs. 9.2). The geographic distribution of wolf relocations and wolf kills shifted in 1978 to an area where moose numbers had also increased. An equation was derived for calculating true kill rates when relocation flights were spaced more than one day apart. Summer food habits of wolves, as determined by analysis of 1723 scats (2095 items) collected on cutlines, at den sites, and at rendezvous sites, indicated that adult moose remained the staple food in all areas. Utilization of beaver (*Castor canadensis*) was highest where beaver densities were

highest. Wolves annually consumed about 11 to 12% of adult moose in the Muskeg River drainage (AOSERP study area); this was 70% of annual recruitment of calves to the moose population. Wolves captured at dump sites associated with oil development were in poorer physical condition than those captured in undisturbed areas. Two lone wolves and two of the packs on the AOSERP study area were partially dependent on dumps for food during winter; predation rates by these packs were much lower. Wolf densities near disturbed sites were higher than on surrounding areas.

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The research was supervised jointly by the Department of Wildlife Ecology, University of Wisconsin, Madison, and the Alberta Fish and Wildlife Division. The field assistance of J. Jorgenson, T. Hauge, O. Harms, A. Harms, D. Keith, D. Thomas, R. Rolley, F. LaBonte, G. Lynch, numerous AOSERP researchers and staff, and the pilots and crews of Life Air Ltd. and Alert Aviation Ltd. is gratefully acknowledged. L. Carbyn and A. Kennedy of the Canadian Wildlife Service helped with scat analyses, and J. Cary was indispensable as the computer programmer.

1. INTRODUCTION

Relationships between wolves (*Canis lupus*) and moose (*Alces alces*) have been detailed through continuing studies on Isle Royale, Michigan (Mech 1966; Jordan et al. 1967; Peterson 1974; Wolfe and Allen 1973) and more recently in Alaska (R. Peterson personal communication; R. Stephenson personal communication). Most investigations of wolf population dynamics in the Boreal Forest have been conducted where white-tailed deer (*Odocoileus virginianus*) are the major prey (Kolenosky 1972; Mech 1973, 1977a, 1977b; Mech and Frenzel 1971; Mech and Karns 1977; Pimlott et al. 1969; Van Ballenberghe et al. 1975; Voight et al. 1976).

Ongoing oil development in the Athabasca Oil Sands of northeastern Alberta (Figure 1) will soon expose wolves and their prey to markedly increased human disturbance. The present study was initiated to provide baseline information on wolf population dynamics and impacts of wolf predation on moose. This paper describes the results of the field work from October 1975 through June 1978.

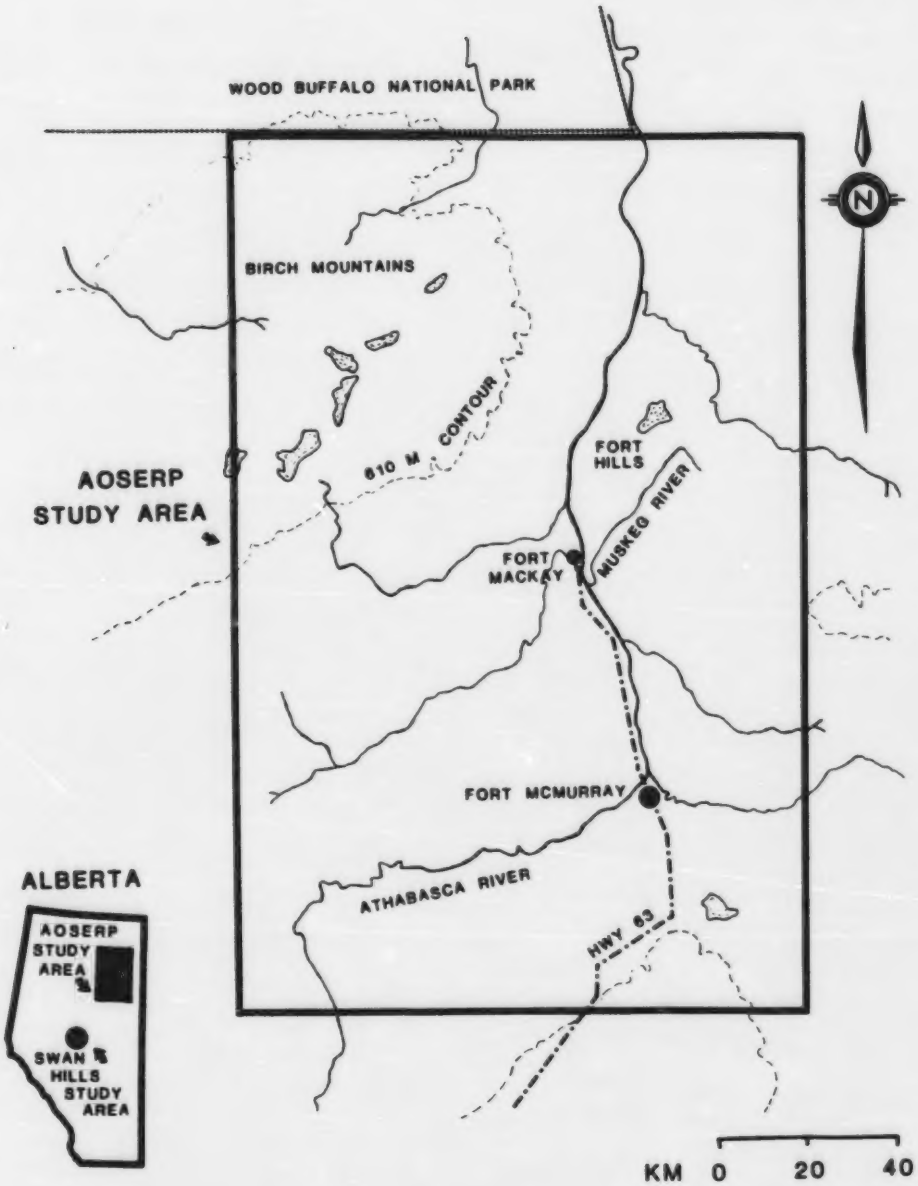

Figure 1. Map of the AOSERP study area.

2. STUDY AREAS

At its outset, the Alberta Oil Sands Environmental Research Program (AOSERP) established a 25 000 km^2 study area (Figure 1) encompassing most minable sections of the oil sands, and those adjacent areas which would be affected directly or indirectly by oil development.

This entire area was studied, but efforts were concentrated where studies of moose and woodland caribou (*Rangifer tarandus*) populations were also taking place.

Moose studies were centred on about 2200 km^2 in the Athabasca River valley near Fort MacKay (Hauge and Keith 1979). Elevations there are between 300 and 450 m. Willow (*Salix* spp.) predominates along slow-moving streams, while black spruce (*Picea mariana*) and tamarack (*Larix laricina*) occur throughout the fens and muskegs of low areas. Stands of mature white spruce (*Picea glauca*), jack pine (*Pinus banksiana*), and mixed trembling aspen (*Populus tremuloides*) and conifers are found on the uplands. Aspen is predominant in the Fort Hills to the north and in the southern foothills of the Birch Mountains to the west (Figure 1). There is intensive oil development on two sites totalling approximately 75 km^2 south of Fort MacKay. These include the construction areas and dumps, heavily utilized roads and clearings, and residence camps associated with the Suncor, Inc. and Syncrude Canada Ltd. extraction plants. Numerous cutlines transect the area, both east and west of the Athabasca River, and access is thus good in winter.

Woodland caribou studies were centred on about 7000 km^2 in and near the Birch Mountains (Fuller and Keith 1979). Forest cover in these highlands (800 to 900 m ASL) consists mainly of black spruce muskegs and upland conifer stands. Aspen is confined largely to ridges surrounding several large lakes and to the lower elevations on the southern slope of the mountains. Farther to the south lie large areas of open and semi-open fens and muskegs, with interspersed mixed conifer and aspen stands. There are few cutlines in the area and access is poor throughout the year. Moose are scarce in the mountains during winter (Hauge and Keith 1979).

Since the winter of 1970-71, the Alberta Fish and Wildlife Division had monitored moose populations on about 600 km^2 along the east slope of the Swan Hills, 300 km southwest of the AOSERP study area. Wolf populations were examined there in winter of 1975-76 to gain additional information on moose-wolf relationships. Topography is characterized by north-south ridges interlaced with muskegs and creeks. There is a gradual eastward decline in elevation from 1100 m to 700 m. Aspen covers most ridge tops and the flatlands to the east, lodgepole pine (*Pinus contorta*) and jack pine the sandy, more xeric sites, and white spruce most of the remaining uplands. Treed muskegs are dominated by black spruce and tamarack, but open bogs with willow and scrub birch (*Betula glandulosa*) are common. The eastern portion of the study area was swept by fire in 1968. There is a single access road with numerous spurs to oil wells on the west, but no access from the east. Cutlines from past oil exploration form a 3 km grid over the entire area.

3. METHODS

Wolves were darted from a helicopter or steel-trapped. All were immobilized with either phencyclidine (Seal et al. 1970) or etorphine, weighed, measured, radiocollared, and released. Subsequent relocations were made at weekly intervals from fixed-wing aircraft, as described by Mech (1974). Locations were first plotted on Alberta forest cover maps, then transformed to metric-grid co-ordinates.

Scats were collected on trails and at den and rendezvous sites during the summer; prey remains were identified by macroscopic examination, comparison with known material, and hair-scale impressions (Frenzel 1974). Moose killed by wolves were examined for debilitating abnormalities; bone marrow was also checked as an indicator of general condition (Mech 1966); and lower jaws were collected for age determination from tooth-cementum annuli (Sargeant and Pimlott 1959).

Predation rates in winter were determined using data from daily relocation flights during 15 January to 10 March 1977 and 21 January to 28 March 1978.

Trappers re-registering traplines within the AOSERP study area were requested to fill out a questionnaire on wolf observations in the winter of 1976-77 to help estimate total wolf numbers and distribution. Annual trapping affidavits and Fish and Wildlife Division poisoning records were examined for indications of past population trends.

4. RESULTS AND DISCUSSION

4.1 DRUG PERFORMANCE

Three wolves darted from the air and nine caught in steel traps were immobilized with etorphine within 3 to 10 min, depending on injection site (Table 1). Recovery after intraveneous injection of the antidote drug (diprenorphine) usually took from 3 to 6 min with no apparent ill-effects. One animal, not included above, convulsed for a short time during handling and subsequently took 60 min to recover; another took 20 min to recover when some antidote was injected intramuscularly. Five other trapped wolves were immobilized with phencyclidine; one died of unknown causes shortly after handling.

4.2 RELOCATIONS OF CAPTURED WOLVES

From early November 1975 to March 1978, 12 wolves (7 males, 5 females) were radiocollared on the AOSERP study area and 3 (1 male, 2 females) in the Swan Hills (Table 2). One adult was subsequently recollared, and three pups trapped in summer were eartagged only. Wolves on the AOSERP area were aerially relocated 869 times from August 1976 to June 1978; those in the Swan Hills were relocated 65 times from November 1975 to July 1976. No data were collected from mid-April through June 1977.

Relocations of radiocollared wolves on the AOSERP study area enabled us to identify and follow four packs and two lone wolves (Figure 2). A fifth pack was observed during summer 1977, and food habit information was collected at its rendezvous site.

The adult male of the Louise Creek Pack (Figure 2) was captured in the Birch Mountains in March 1976 and left the area in November. A member of the Muskeg River Pack was first caught in August 1976 and continuous contact with the pack was maintained through June 1978 by radiocollaring three additional animals. Three Syncrude Pack wolves, captured in November 1977, were monitored through January 1978; a fourth animal was collared and relocated in

Table 1. Etorphine dosages and immobilization statistics for 12 wolves captured on the AOSERP study area between March 1976 and March 1978.

	Means and ranges
Etorphine dosage (mg)	0.9 (0.2-2.0)
Immobilization time (min)	5.2 (3-10)
Recovery time (min)	2.6 (2-6)[a]
Rectal temperature (^{o}C)	38.3 (36.6-40.3)
Heart rate (per min)	14.6 (8-36)
Respiration rate (per min)	69.9 (42-106)

[a] Excludes two animals which took 20 and 60 min to recover.

Table 2. Description of wolves marked on the AOSERP study area between March 1976 and March 1978, and on the Swan Hills study area between November 1975 and January 1976 (last two packs).

Pack Name	Animal Number	Date Captured	Capture method	Sex	Age	Weight (kg)	Fur colour	Fate if radiocollared
Louise Creek	6098	12 Mar 76	dart	M	ad	43	gray	Dispersed Nov 76; found dead Jan 77 100 km SW
Muskeg River	6126	4 Aug 76	trap	M	yrlg	44	black	Radio failed Jul 77
	6130	18 Jan 77	dart	M	pup	36	black	Radio failed Jan 78
	6132	22 Jan 77	dart	M	ad	57	gray	Reradiocollared Jan 78
		26 Jan 78	trap			55		Radio functioning Jun 78
	6136	20 Nov 77	trap	F	ad	34	black	Radio functioning Jun 78
Syncrude	6120	19 Jul 77	trap	M	pup	8	black	
	6122	20 Jul 77	trap	M	pup	9	black	
	6123	20 Jul 77	trap	M	pup	8	black	
	6163	12 Nov 77	trap	M	pup	29	gray	Radio failed Jan 78
	6167	12 Nov 77	trap	M	pup	30	gray	Trapped Dec 77 - Jan 78
	6169	27 Nov 77	trap	M	ad	48	gray	Radio failed Jan 78
	6145	7 Mar 78	trap	F	pup	31	gray	Radio functioning Jun 78

Continued ...

Table 2. Concluded.

Pack Name	Animal Number	Date Captured	Capture method	Sex	Age	Weight (kg)	Fur colour	Fate if radiocollared
Black	6173	17 Feb 78	trap	F	ad	42	Black	Radio functioning Jun 78
(lone wolf)	6168	3 Feb 78	trap	F	ad	32	gray	Radio failed or animal dispersed Apr 78
(lone wolf)	6171	17 Feb 78	trap	F	ad	33	gray	Radio functioning Jun 78
Foley Lake	90	5 Nov 78	trap	F	pup	30	black	Radio failed Jul 76; possible dispersal 50 km SW
	96	30 Jan 76	trap	M	yrlg	45	black	Radio failed Jul 76; shot as pest animal Sept 77 on south edge of former range
Saulteaux River	92	10 Nov 75	trap	F	ad	43	gray	Killed by Foley Lake pack late Jan 76
	94	11 Nov 75	trap	M	pup	43	black	Died soon after handling

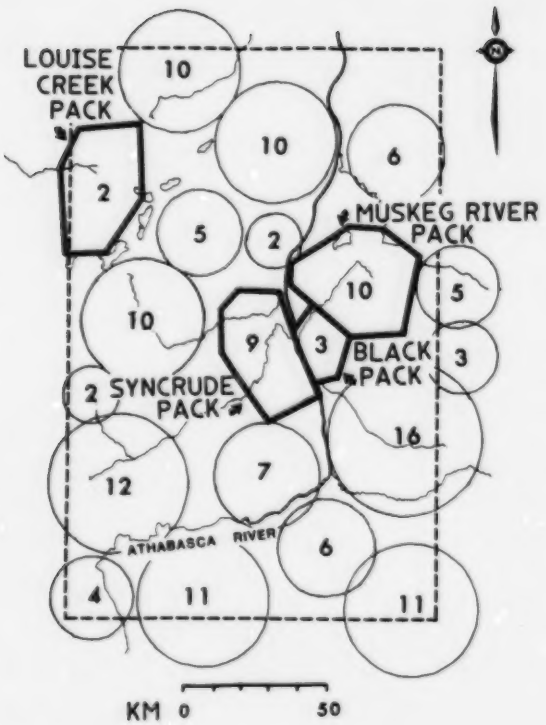

Figure 2. Location and number of wolves in radiocollared and non-radiocollared packs on the 25 000 km^2 AOSERP study area in winter.

March through June 1978. This pack's territory included areas cleared for oil extraction and plant construction. An adult female wolf in the Black Pack was collared and relocated from mid-February to June 1978. Two lone wolves, both females, were captured at a refuse site adjacent to the development clearings in early February 1978. One was relocated through April and the other through June 1978. The Dover Lake Pack (no captured animals) was observed in summer 1977 on the southern slope of the Birch Mountains.

The three wolves radiocollared in the Swan Hills were members of two different packs. A third pack was identified from ground tracking in the western half of the area. An adult female in the Saulteaux River Pack was relocated from early November 1975 to the end of January 1976 in the northeastern portion of the area. Two members of the Foley Lake Pack were followed from November 1975 to July 1976 and January 1976 to July 1976, and ranged over an area immediately south of the Saulteaux River Pack's territory.

4.3 NUMBERS AND DISTRIBUTION

During winter, wolf packs are territorial (Peters and Mech 1975) and thus an estimate of wolf densities in an area can be made by determining: (1) the number of packs present; (2) the number of wolves in each pack; (3) the size of pack territories; and (4) the number of lone wolves present (Mech 1973).

The mean number of wolves in radiocollared wolf packs on the AOSERP study area ranged from two to 10 during winter (November to April). Winter territories covered 357 to 1779 km^2 (Table 3), based on the minimum-perimeter-polygon method (Mohr 1947). Summer territories of packs with pups ranged from 195 to 682 km^2, generally much smaller than in winter. The Louise Creek pair was located only 10 times in late winter 1975-76 and their winter territory was likely much larger than was observed. The two lone wolves had winter ranges of 95 km^2 each; in summer, one of them had increased her range to 237 km^2. Winter densities on territories of radiocollared packs averaged one wolf/156 km^2 (range: 73 to 273 km^2)

Table 3. Seasonal territory sizes of radiocollared wolves on the AOSERP and Swan Hills (last two packs) study areas, November 1975 to June 1978.

Pack name or lone wolf number	Season	Range observation dates	Total no. of wolves in pack	Total no. radio-collared wolves	No. of pack (and individual) locations	Territory size (km^2)[a]	Winter wolf density (km^2 per wolf)
Muskeg River	Summer	4 Aug - 29 Oct 76	4adults, ≥6pups	1	21	429	
	Winter	3 Nov 76 - 24 Apr 77	8-10	1-3	114 (255)	1779	198
	Summer	23 Jul - 28 Oct 77	8adults, ≥5pups	2-3	38 (55)	571	
	Winter	5 Nov 77 - 30 Apr 78	9-13	2-3	131 (201)	1262	115
	Summer	1 May - 30 Jun 78	8adults, ≥4pups	1-2	36 (40)	426	
Syncrude	Winter	12 Nov 77 - 27 Apr 78	7-12	1-3	61 (65)	689	
	Summer	1 May - 30 Jun 78	5-9adults, ≥7pups	1	26	435	
Black	Winter	17 Feb - 27 Apr 78	3	1	55	357	119
	Summer	1 May - 30 Jun 78	2-3adults, ?pups	1	17	195	
Louise Creek	Winter	12 Mar - 30 Apr 76	2	1	10	546	273
	Summer	1 May - 12 Oct 76	2adults, ≥3pups	1	28	682	

Continued ....

Table 3. Concluded

Pack name or lone wolf number	Season	Range observation dates	Total no. collared in pack	Total no. radio-collared wolves	No. of pack (and individual) locations	Territory size (km^2)[a]	Winter wolf density (km^2 per wolf)
6171	Winter	17 Feb - 27 Apr 78	1	1	40	95	
	Summer	1 May - 30 Jun 78	1	1	16	237	
6168	Winter	3 Feb - 18 Apr 78	1	1	40	95	
Foley Lake	Winter	5 Nov 75 - 18 Apr 76	7	1-2	26 (37)	645	92
Saulteaux River	Winter	10 Nov 75 - 31 Jan 76	6	1	11	237 (528)[b]	40 (88)[b]

[a] Area determined by minimum-perimeter-polygon method (Mohr 1947).

[b] Numbers in parentheses are the best estimates of territory size and density as determined from the ratio (with Foley Lake Pack) of 95% probability ellipses of home range sizes (Jenrich and Turner 1969).

The authors' own information on size and location of pack territories was used, together with that from the trapper questionnaire, to estimate the total number of wolves on the 25 000 km^2 AOSERP study area. Trappers were asked to report numbers, colours, and locations of wolves seen during the winter of 1976-77 in an effort to identify individual packs and estimate the proportion of single animals on the area. Trappers on 46 of 54 active traplines responded to the questionnaire (Figure 3); 24 saw one or more wolves. This information, other reported wolf sightings, and the authors' telemetry data and observations were used to map pack locations and to estimate mean size of each pack (Figure 2).

It was calculated that wolf numbers totaled 140 in the winters of 1976-77 and 1977-78 (about 1/179 km^2) by: (1) including only a portion of the animals in packs with territories on the edge of the study area; (2) assuming that 17% of all wolves in the area were lone wolves (79 of 467 observed incidentally by trappers or project personnel were alone); and (3) assuming that all packs were accounted for.

There were six and seven wolves in the two radiocollared packs in the Swan Hills (Table 3). They occupied territories estimated at 528 and 645 km^2 (about 1 wolf/90 km^2). A third pack of eight or nine animals lay just to the west, and an estimated four to five lone animals were also present. In an area of approximately 2000 km^2, there was thus a total of 26 wolves, a mean density of 1/77 km^2.

Densities on Isle Royale have ranged between 1/17 to 32 km^2 (Peterson 1974). R. Stephenson (pers. comm.) reported mean densities of one wolf/153 to 322 km^2 in Alaska. Densities elsewhere in North America have varied between one wolf/12 to 520 km^2 (from Mech 1970:66).

The differences in wolf density observed seemed related to ungulate abundance. Densities of moose (1/33 km^2, Hauge and Keith 1979) and woodland caribou (1/24 km^2, Fuller and Keith 1979) in the Birch Mountains were very low in winter, as were apparent wolf numbers. There was, for example, one wolf/237 km^2 in the territory of the Louise Creek Pack, but 1/126 km^2 in pack territories along the Athabasca

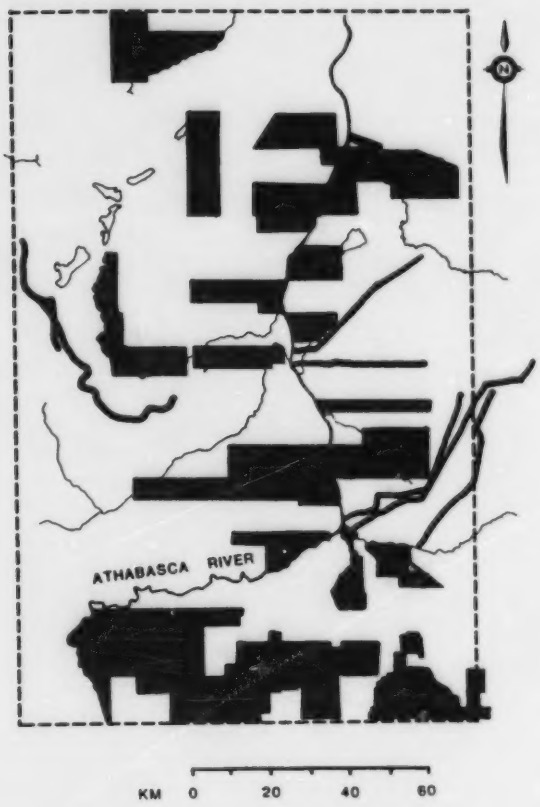

Figure 3. Distribution of registered traplines of respondents to the wolf observation questionnaire in the winter of 1976-77.

River valley. In addition, the average number of wolves (4.4) seen in 35 groups near the Athabasca River in winter was significantly greater than the average (1.9) for eight groups in the Birch Mountains; Rausch (1967) reported that the frequency of larger packs was greatest among high density populations in Alaska. Moose densities in the Swan Hills (1/0.5 km^2, G. Lynch pers. comm.) were eight times those on most parts of the AOSERP study area (1/3.8 km^2, Hauge and Keith 1979); and wolf densities in the Swan Hills were over twice as high (1/77 vs. 1/179 km^2).

4.4 POPULATION CHANGES

Numbers of wolves in the AOSERP study area may have increased recently. The Muskeg River Pack comprised four wolves in winter of 1975-76, up to nine in 1976-77, and 10 in 1977-78. The Syncrude Pack increased from six in the winter of 1975-76 (Penner 1976) to at least nine by 1977-78.

Trapping and poisoning records and trapper interviews suggest that, twice in the recent past, numbers of wolves in the Swan Hills were much higher than in the winter of 1975-76 (26 wolves). From March 1965 to January 1976, 32 wolves in five packs were poisoned on two lakes in the western half of the study area. During the winter of 1971-72, 20 wolves were trapped or shot there. At least five of these animals had advanced cases of mange, and it is possible that many other wolves were trapped but discarded and not reported. Since wolf numbers in years following these large harvests were not noticably depleted (O. Harms pers. comm.), many wolves were probably not taken.

4.5 REPRODUCTION AND MORTALITY

Mating activity on the AOSERP study area was observed in late February and early March 1978. Den sites were first located in late April and early May during both 1976 and 1978. The Foley Lake Pack in the Swan Hills split up in late April 1976, and probably denned soon afterwards.

At least three pups were present at the Louise Creek den site in the summer of 1976. The pups disappeared by that fall, as did the adult female; and by November, the radiocollared male had evidently moved well off the study area. In late January 1977, this wolf was found dead on a cutline 150 km southwest of his original territory. He was emaciated, having lost 30% of his body weight since the previous March, and it is believed that he died of starvation.

In the winter of 1975-76, the Muskeg River Pack numbered four. In the fall of 1976, four adults were seen with six pups. By the end of winter, eight animals were left with a ninth present occasionally. The tenth wolf disappeared in mid-January, and may have died after partial immobilization during an unsuccessful darting attempt. In mid-July 1977, four pups were observed at the pack rendezvous site. On 19-20 July, three of these pups were captured; all were males weighing 8 to 9 kg and appeared to be in good condition. Throughout the fall of 1977, as many as 13 individuals were seen in the pack, but by late winter only eight to nine were regularly present. In June 1978, four pups were again seen at the den site.

The Syncrude Pack apparently numbered six in the winter of 1975-76 and eight in 1976-77. In early winter 1977-78, up to 12 animals were observed. One radiocollared and one unmarked pup were taken by trappers in January. By late winter, at least eight animals were present, but an accurate total count was difficult as pack members often travelled in smaller groups. Seven pups were seen at the den site in June 1978.

The Black Pack numbered three animals in late winter 1978. All appeared mangy and in poor condition. The radiocollared adult female denned in late April but the den site was abandoned in May and no other site was established. Thus, if pups were born, none likely survived.

Several incidental observations of wolf mortality were also made on the AOSERP study area. Remains of an adult grey wolf were found at the Muskeg River rendezvous site in July 1977. This wolf, a non-pack member, was apparently killed by adults and consummed by

pups at the site. One yearling wolf was found after she was hit by a vehicle near Fort McMurray. One wolf was observed feeding at a roadside on the carcass of another wolf which also could have been hit.

The radiocollared female wolf of the Saulteaux River Pack in the Swan Hills was found dead in late January on a lakeshore where the previous week she had been observed near a kill with the neighboring Foley Lake Pack. Numerous tooth punctures on the hips and flanks, and two large wounds on either side of the neck, indicated that she was probably killed by the other pack. One of the radiocollared wolves in the Foley Lake Pack was trapped by a government control officer after it had been seen repeatedly on the edge of farmland, and was feeding on livestock carcasses. It was not far from the southern edge of the pack's territory but appeared in very poor condition. The other radiocollared animal in the pack may have left the area as it was apparently sighted 50 km southwest of the pack's territory.

Records from the Fish and Wildlife Division at Fort McMurray indicated that from 1971-72 to 1976-77 an average take of 14 wolves was reported by trappers on the AOSERP study area each winter (Table 4); this would be about 10% of the total estimated population. In the Swan Hills, trappers took an average of five wolves per year from 1971-72 to 1975-76, or about 19% of the population.

Minimum estimates of yearly changes in wolf numbers could be derived for three packs in the AOSERP study area during five pack-years. These packs averaged 5.6 members in early spring and produced a mean minimum of 4.0 pups per pack. By late fall, packs averaged 9.0 members, an over-summer increase of 61%. By the following spring, mean pack sizes had decreased to 6.8, an over-winter disappearance rate of 24%. The observed finite rate of increase was thus 1.21 annually, or 21%.

A mean of at least 3.9 pups was observed in eight litters on the AOSERP study area. This is similar to values reported when wolves were not intensively trapped or food short (Mech 1970, 1977b). Actual pup production may have been much higher, but rates and causes of early mortality are unknown. Mech (1977b) reported a mean spring-to-winter population increase of 39% (range: 15 to 64%) vs. 61% in the present study area.

Table 4. Reported numbers of wolves captured during winter on registered traplines on the AOSERP study area, 1971 to 1977 (from Alberta Fish and Wildlife Division, Fort McMurray).

Winter	No. of active traplines reporting[a]	No. of wolves trapped
1971-72	51	19
1972-73	61	17
1973-74	55	10
1974-75	52	10
1975-76	49	14
1976-77	54	13
Means	54	14

[a] Trappers were required to file an affidavit each year stating their fur catch of the previous winter. Those failing to file were not permitted to trap during the coming winter. Total number of inactive or unassigned traplines each year was approximately 25 to 30.

Dispersal, in addition to mortality, may have also reduced pack size over winter. Thus, the calculated disappearance rate (24%) likely overestimated winter mortality. Mech (1977b) found an over-winter disappearance rate of 23% (range: 2 to 46%) but calculated annual mortality of 40% (range: 7 to 65%). A wolf population with an adequate prey base can sustain up to 50% mortality yearly without being depressed (Mech 1970: 64).

Causes of adult wolf mortality on both the AOSERP and Swan Hills study areas apparently included starvation, intraspecific strife, trapping, and accidents. These were also the major causes of mortality found by Mech (1977b) in Minnesota.

4.6 AGE AND SEX OF MOOSE KILLED BY WOLVES

From March 1976 through June 1978, two woodland caribou and 50 moose that were killed by wolves were examined on the AOSERP study area. Both caribou and two of the moose were in the Birch Mountains. The other 48 kills were situated within territories of the Muskeg River, Syncrude, and Black packs. The age distribution of these 48 moose differed significantly from that observed in the moose population (Figure 4). Calves and old moose ($\geq$11.5 years) were taken more often than expected, middle-aged moose (2.5 to 5.5 years) less often. Thirteen of 14 calves killed were females; but none of the seven 1.5 to 5.5 year olds killed were cows (Table 5). The proportion of yearling and adult bulls taken was significantly higher than was observed in the winter population. There were no significant time-specific differences in wolf kills by sex or age class.

Seven of 45 moose killed by wolves were probably debilitated. Two had arthritic leg joints, two had low marrow fat, one had "lumpy jaw" (actinomycosis), one was possibly still under the influence of an immobilizing drug, and one radiocollared animal had a hole in its flank and low hematocrit count. Four other moose had minor abnormalities; three had malformed tooth rows and one a crossed hoof.

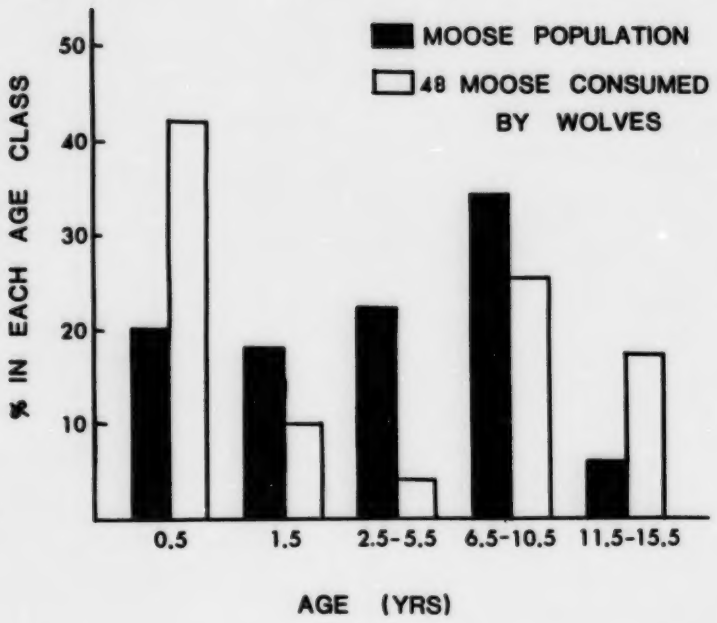

Figure 4. Age distribution of moose consumed by wolves and of the moose population on the AOSERP study area during late August to May 1976-77 and 1977-78.

Table 5. Percent of bulls among moose consumed by wolves during late August to May, 1976-77 and 1977-78, and in the population surveys on the AOSERP study area during February 1977 and December 1977.

Age (yr)	Wolf-consumed moose		Moose population[a]	
	% Bulls	No. of moose	% Bulls	No. of moose
0.5	7	14		
1.5 - 5.5	100	7		
6.5 - 15.5	48	21		
Total adult[b] (≥1.5)	51	28	38	405

[a] From Hauge and Keith (1979).

[b] Percent bulls significantly different (≥0.02).

Wolves were twice located feeding on adult bull moose known to have died in fights with other bulls during the rut. One had been gored in the flank, and two others had locked antlers. One adult cow that died during tagging was scavenged, as were the remains of eight hunter-killed moose.

Eight encounters were observed between moose and wolves. Twice moose stood in water as wolves waited on shore; neither outcome was determined. The Muskeg River Pack trailed a walking cow and calf closely, occasionally rushing the cow in an apparent attempt to separate her from the calf. When the cow and calf stopped walking, the wolves lay down within 50 m. When located the next morning, the wolves had killed a calf 5 km away. This was perhaps the animal seen the day before. Two single moose and one cow with a calf stood and faced wolves; in each case the wolves soon moved on. Twice single moose outran the one or two pack members that pursued them through upland aspen stands.

The above information on sex, age, and condition of wolf-killed moose, along with wolf-moose encounter observations, indicate prey selection and hunting success similar to that reported elsewhere (Mech 1966; Mech and Frenzel 1971; Peterson 1974). Wolves were apparently not able to kill at will, and thus took a disproportionate number of young, old, and probably debilitated moose. Ages of the six wolf-killed moose (0.5, 0.5, 6.5, 7.5, 8.5, 8.5 years) from the Swan Hills and the Birch Mountains supported this conclusion.

4.7 ACTIVITY, MOVEMENTS, AND KILL-RATES OF THE MUSKEG RIVER PACK

Certain aspects of wolf ecology and behaviour during winter reflect population status and trends (Mech 1977a). Prey consumption rates and pack activity, for example, may indicate prey availability and a pack's physical condition. Consumption rates and activity were determined by relocating the Muskeg River Pack at least once daily during 15 January to 10 March 1977 and 21 January to 28 March 1978.

The winter of 1977 was milder than 1978; snow depth averaged 40% less due to less snowfall and warmer February temperatures (Table 6). Snow was not crusted in either year.

Table 6. January to March meteorological summaries for Fort McMurray airport, Alberta (Atmospheric Environment Services).

Month	Snow on ground at months end (cm)			Total monthly snowfall (cm)			Mean daily temperature (°C)		
	1977	1978	Mean (1946-72)	1977	1978	Mean (1946-72)	1977	1978	Mean (1946-72)
January	19	30	36	8	13	22	-13.7	-21.3	-21.5
February	20	34	38	6	14	19	-3.4	-13.2	-16.6
March	20	36	28	38[a]	17	19	-5.0	-6.7	-9.3

[a] Only 3.0 cm of snow had fallen by 10 March 1977.

Table 7. Mean number of days (±SE) that the Muskeg River wolf pack spent at moose kill sites during 15 January to 10 March 1977 and 21 January to 28 March 1978. Number of kill sites are shown in parentheses. Days spent revisiting old kill sites are not included.

Year	Days at kill site		
	Calf kill	Adult kill	Weighted mean
1977	1.3 ± 0.2 (5)	1.9 ± 0.2 (7)	1.7 ± 0.1
1978	1.8 ± 0.2 (5)	3.1 ± 0.4 (7)	2.5 ± 0.3
Totals	1.5 ± 0.2	2.5 ± 0.2	2.1 ± 0.2

The Muskeg River Pack was contacted on 55 consecutive days in 1977; its three radiocollared animals were located 222 times for 86 pack locations. Mean time between consecutive contacts was 15.5 h (±8.3 standard deviation). Part or all of the pack was observed on 96% of relocation attempts, greatly aiding the efforts to determine activities and kill sites.

The pack was contacted on 66 of 67 days in 1978; its three radiocollared animals were located 154 times for 98 pack locations. The mean time between consecutive locations was 16.3 h (±8.3 standard deviation); part or all of the pack was observed on 99% of relocation attempts.

It is believed that all moose killed or scavenged by wolves were found by the authors during the above two periods. The pack remained at kills of adult moose for an average of 2.5 days, and at kills of calves for 1.5 days (Table 7). The pack could have killed and consumed a calf moose and then left the kill site between some relocation flights, but this was highly unlikely.

Mean pack size at kill sites was 9.2 in 1977, 9.8 in 1977, and 9.8 in 1978. On the average, the pack killed and/or consumed a moose once every 4.6 days in 1977 and 4.8 days in 1978 (Table 8). In 1977, the mean number of days between kills was similar following either a calf or adult kill (4.5 vs. 4.7 days). But in 1978, the interval was much less following calf vs. adult kills (2.3 vs. 7.0 days). Calves comprised approximately 46% of kills in both winters. On four occasions each year, the pack returned to previous kill sites to scavenge remains. Kills were usually examined within 2 days; in all cases, 90 to 100% of the edible portions had been consumed. It is assumed that 75% by weight of any carcass was consumable (Peterson 1974), and it is calculated that, in 1977, 3078 kg of prey were eaten by an average of 9.2 wolves during 55 days. In 1978, 3237 kg were eaten by 9.8 wolves in 67 days. Average food consumption was therefore 6.1 kg/wolf/day in 1977 and 4.9 kg/wolf/day in 1978.

Both moose and wolves utilized upland and lowland habitats in approximately equal proportions, but kills were situated much more frequently in lowlands (Table 9). No significant differences occurred

Table 8. Mean number of days (±SE) between moose kills made by the Muskeg River wolf pack during 15 January to 10 March 1977 and 21 January to 28 March 1978. Number of kills are shown in parentheses.

	Days until next kill		
	After calf kill	After adult kill	Weighted mean
1977	4.5 ± 0.9 (4)	4.7 ± 0.6 (7)	4.6 ± 0.5
1978	2.3 ± 0.4 (6)	7.0 ± 1.6 (6)	4.8 ± 1.0
Totals	3.4 ± 0.5	5.8 ± 0.9	4.7 ± 0.6

Table 9. Percent lowland habitat use by moose, and by the Muskeg River wolf pack when hunting (≥1 km from previous kill site), vs. percent of wolf kills in lowland habitat, January to March 1977 and 1978.

	1977		1978	
	% of observations in lowland[a]	No. of observations	% of observations in lowland[b]	No. of observations
Moose[b]	48	225	39	130
Wolves hunting	41	44	53	47
Wolf kills	91	11	85	13

[a] There were no statistically significant differences between habitat use by moose or hunting wolves in either year (all four $p > 0.09$ Percent of wolf kills in lowland habitats was significantly different (both $p > 0.03$) than percent habitat use by moose or hunting wolves in both years.

[b] From Hauge and Keith (1979).

during January to March in habitat use among those sex or age classes taken most often by wolves (Hauge and Keith 1979). Perhaps more chases, successful and unsuccessful, ended in lowland areas and hence more moose were killed there. Theoretically, the deeper uncrusted snow in lowlands should have made moose less vulnerable to predation (Peterson and Allen 1974).

The geographic distribution of wolf kills shifted somewhat in the winter of 1978, a greater proportion of all kills being made northwest of the Muskeg River, in or near the Fort Hills (42 vs. 17%; Figures 5 and 6). This coincided with a 32% increase in the proportion of moose observed there (Hauge and Keith 1979).

The pack rested or slept, travelled, or fed during an average of 63, 22, and 14% of the observations. These figures were similar between winters. Fourteen of 15 kills, for which the time could be estimated to the nearest 12 h were made between 1600 and 0900 h.

Distances travelled and the size of the area over which the pack ranged differed markedly between years. The average distance between daily locations was 9.0 km in 1977 and 5.7 km in 1978. The average distance travelled between kills was 44 km in 1977 but only 25 km in 1978. In 1977, the pack ventured out of its territory for short periods of time, twice to the north and once to the west (Figure 5). The pack sometimes moved long distances during short periods of time in 1977 and, unlike in 1978, travel rates were as great during the day as at night. Calculated home range size was thus much larger in 1977 (1627 km^2) than in 1978 (1023 km^2).

Most researchers have found no evidence of a cyclical or predictable pattern in the movements of wolves (Kolenosky 1972; Mech 1966; Pimlott et al. 1969). The Muskeg River Pack exhibited no recognizable circuits of travel in either year; but activity centred near Kearl Lake and the pack did return there often (Figures 5 and 6).

Wolves in northern Alberta are, on the average, 40 to 45% heavier (38 kg; Table 2) than in the Great Lakes Region (27 kg; Kolenosky 1972; Mech 1977a; Pimlott et al. 1969). Consumption rates were thus compared as kg prey/kg wolf/day. Several authors have

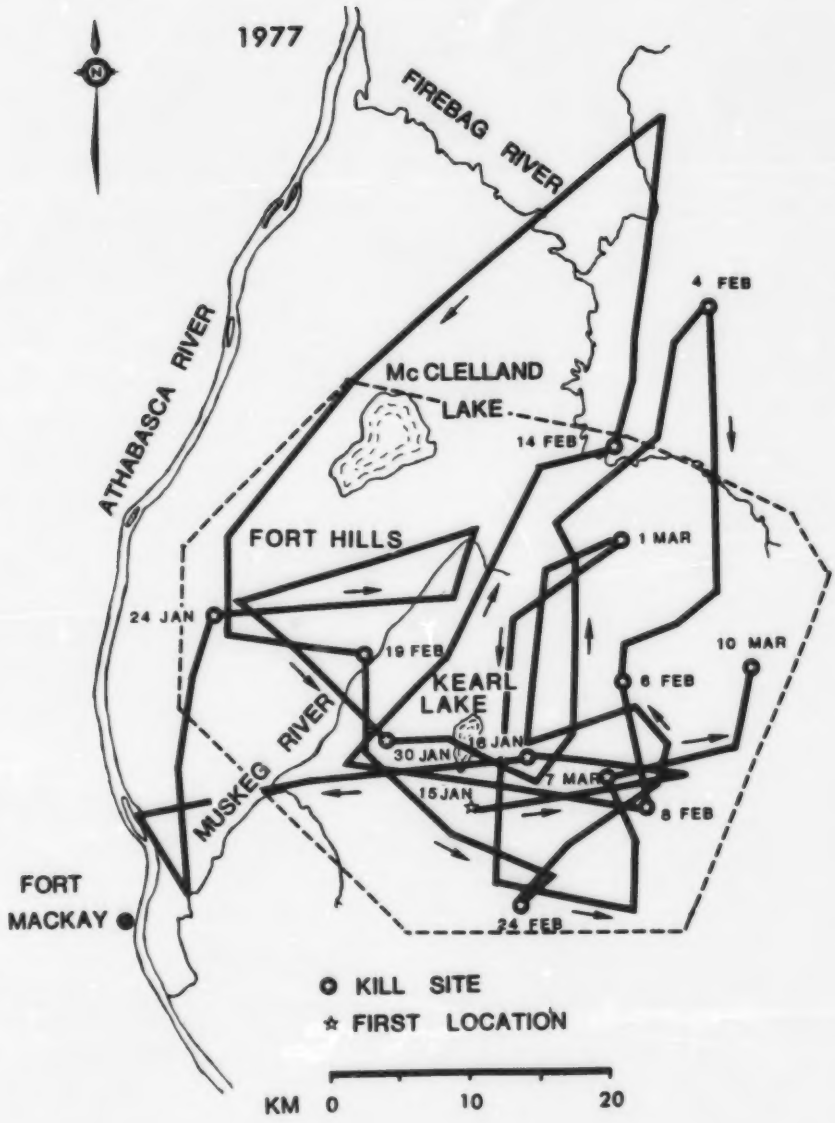

Figure 5. Kill-site locations date of kill, and travel pattern of the Muskeg River wolf pack as determined from consecutive daily relocation flights during 15 January to 10 March 1977.

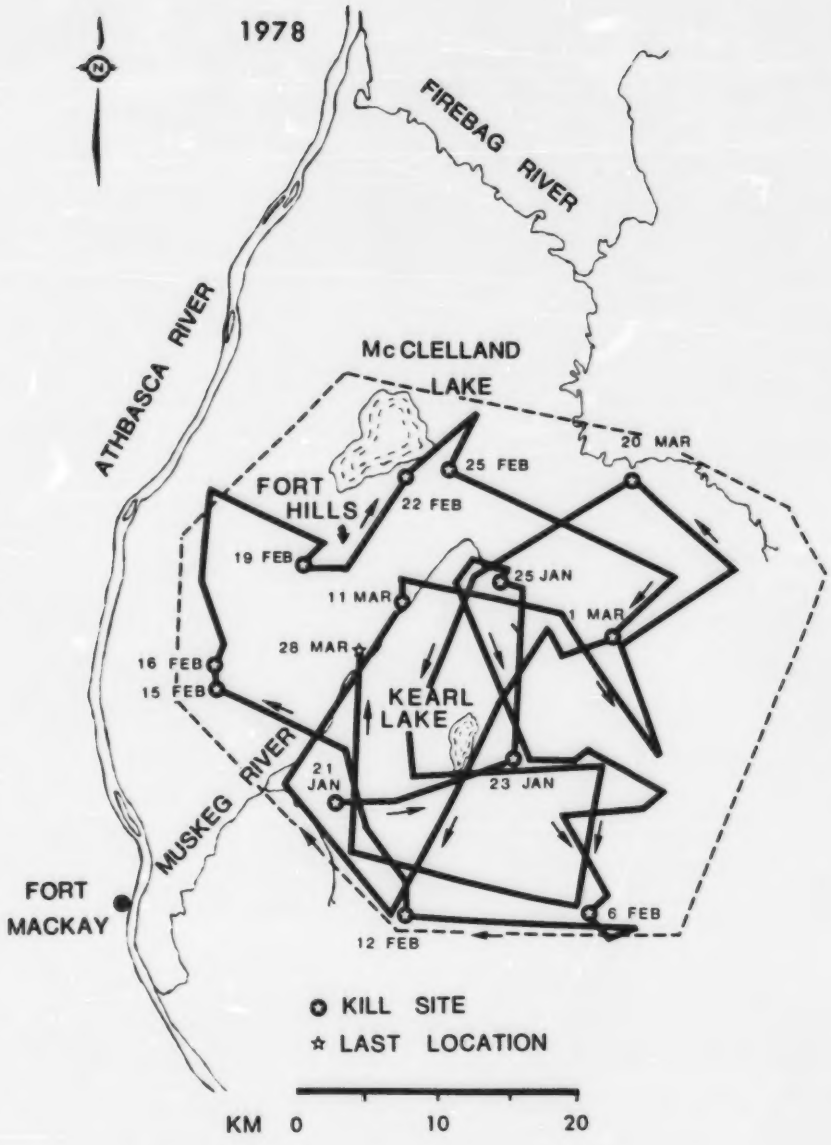

Figure 6. Kill-site locations, date of kill, and travel pattern of the Muskeg River wolf pack as determined from consecutive daily relocation flights during 21 January to 28 March 1978.

suggested that wolves in the wild can maintain body weight in winter by consuming 0.06 kg/kg/day (Kolenosky 1972; Kuyt 1972; Mech 1977a). The Muskeg River pack consumed an estimated 0.15 kg/kg/day in 1977 and 0.12 kg/kg/day in 1978. On Isle Royale, consumption rates were estimated at 0.13 to 0.19 kg/kg/day (Mech 1966) and 0.26 kg/kg/day (Peterson 1974). In Minnesota, Mech and Frenzel (1971) found rates of 0.09 kg/kg/day; and in Ontario, Kolenosky (1972) reported a rate of 0.10 kg/kg/day.

Mech (1977a) suggested that the pack as a whole requires an average of at least 0.13 kg/kg/day for all individuals to survive and for new pups to be reared successfully the following spring. The Muskeg River Pack would therefore have had sufficient food for pup rearing in 1977, though possibly not in 1978.

Mech (1977a) plotted the frequency of certain types of wolf activity (sleeping, travelling, and feeding) over a span of years when their staple prey, white-tailed deer, underwent a major population decline. The frequencies of such activities by the Muskeg River Pack corresponded to years when deer numbers were relatively low but adequate to maintain a stationary wolf population.

Distances travelled (direct point to point) by the Muskeg River Pack averaged 7 km daily and kills averaged 35 km apart. These distances were comparable to those obtained on Isle Royale (Peterson 1974) where prey availability and food consumption were at a moderate level. In the Muskeg River area, they may reflect the obvious difficulty wolves did have catching moose they encountered.

The longer time that wolves remained at kill sites in 1978 (Table 7) probably reflected the increased difficulty of travelling through deeper snow. Because of this longer time at kill sites, mean distance travelled on days when the pack was known to have moved was 21% less in 1978 (11.6 km) than in 1977 (14.6 km). Thus a lower per capita food consumption in 1978 was at least partly compensated for by shorter movements.

4.8 WINTER PREDATION RATES

All moose consumed by wolves, whether killed or scavenged, were included in the kill-rate calculations, and it is assumed that the proportion of calves consumed by each pack was similar. To compare winter kill rates of the Muskeg River Pack with those of packs not contacted daily, the effect of longer intervals between contacts on apparent kill rates was analyzed. Other researchers (Mech 1977a; R. Stephenson pers. comm.) have attempted to calculate kill rates by assuming that the mean number of kills observed per relocation flight represented the mean daily kill rate. But wolves in packs of less than 12 to 15 probably remain at moose kills longer than one day, and the change of locating them at a kill is therefore greater than the actual daily kill rate. Thus, using the daily observations from the Muskeg River Pack, the mean number of kills that would have been observed had the pack been checked at all possible combinations of two- to 10 day intervals was calculated. These hypothetical means were then plotted against their respective intervals (Figure 7). At intervals exceeding six days, the mean number of kills observed per flight remained constant. The regression for intervals up to six days was described by: $Y = 0.31 \log X + 0.22$ ($r^2 = 0.87$).

The daily kill rate (K) for other packs studied was estimated from the mean number of kills observed during relocation flights (Y), the mean number of days (maximum: 6.0) between such flights (X), and the above regression equation. Thus, $K = Y - 0.31 \log X$. The Muskeg River Pack was consistent in its kill rate between winters and throughout the winter of 1977-78 (Table 10). The Syncrude Pack apparently killed moose less than half as often as the Muskeg River Pack in the winter of 1977-78, but visited dump sites several times. The Black Pack was not observed at any fresh kills when relocated on 38 of 40 days in February and March 1978, but did scavenge remains of four hunter-killed moose and also visited a dump site. The Foley Lake Pack in the Swan Hills consumed moose at a slightly higher rate than the Muskeg River Pack.

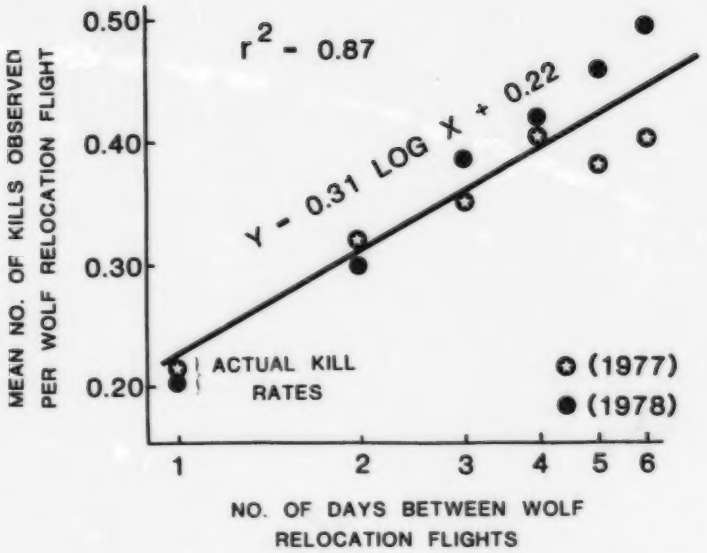

Figure 7. Variation in predation rates by wolves on moose during winter as estimated from daily relocation flights on the AOSERP study area during 15 January to 10 March 1977 and 21 January to 28 March 1978.

Table 10. Consumption rates of moose by wolf packs during winter on the AOSERP and Swan Hills (last pack) study areas.

Pack name	Mean no. of wolves in pack	Range of observation dates	No. of relocation flights	Mean no. of days between relocation flights	Mean no. of kills observed per relocation flight	Calculated no. of moose kills per day[a]	Calculated no. of moose kills per day per day
	9.2	15 Jan - 10 Mar 77	55	1.0	0.22	0.22	0.024
Muskeg River	10.5	5 Nov 77 - 18 Jan 78	18	4.1	0.39	0.20	0.019
	9.8	21 Jan - 28 Mar 78	66	1.0	0.21	0.21	0.021
	8.5	15 Apr - 31 May 78	21	2.2	0.29	0.18	0.021
Syncrude	8.5	18 Nov 77 - 28 Mar 78	41	1.2	0.12	0.08	0.009
Black	3.0	17 Feb - 28 Mar 78	38	1.1	0.00	0.00	0.000
Foley Lake	6.5	13 Jan - 17 Mar 76	10	6.6[b]	0.42	0.18	0.027

[a] The daily kill rate (K) was estimated for each pack from the mean number of kills observed during relocation flights (Y), the mean number of days between such flights (X), and the general regression equation linking the latter two variables as illustrated in Figure 8 ($Y = 0.31 \log X + 0.22$). Thus: $K = Y - 0.31 \log X$.

[b] Used 6.0 days in calculation; see text.

4.9 SUMMER FOOD HABITS

Summer food habits were determined by analyses of 1524 wolf scats (1869 prey items) collected from six den or rendezvous sites and on adjacent trails or cutlines. Approximately 47% of all scats were from pups, as were 48% of all prey items. Data from analyses of adult and pup scats were combined; beaver (*Castor canadensis*) and/or muskrat (*Ondatra zibethicus*) occurred more often in pup scats, but snowshoe hare (*Lepus americanus*) less often; calf and adult ungulates occurred in both pup and adult scats with similar frequency.

No dens were located in the Swan Hills; thus, for comparison, 199 scats (226 items) of undetermined age collected on cutlines in both study areas were analyzed. Percent occurrence of ungulates among total food items was similar in den site vs. cutline scats on two sections of the AOSERP study area (Tables 11 and 12). The authors thus considered the Swan Hills samples as providing the ratio of ungulates to other prey consumed in summer.

Percent occurrence of different food items varied between packs and areas (Table 11). Ungulates ranged from 21 to 75%, adult moose comprising 43 to 69% and calves 25 to 57% (Table 11). Beaver and/or muskrat ranged from 13 to 52% and snowshoe hare from 0 to 20%. An alien adult wolf was consumed by pups at the 1977 rendezvous site of the Muskeg River Pack and totaled 18% occurrence in pup scats. Other items (4 to 9%) included microtines, red squirrel (*Tamiasciurus hudsonicus*), porcupine (*Erithizon dorsatum*), unidentified fish and birds, and garbage.

Differences between summer food habits of wolf packs were probably due to regional differences in prey availability. Although woodland caribou are present year-round in the Birch Mountains (Fuller and Keith 1979), moose and beaver were the main prey (84% occurrence) in scats collected at the Louise Creek den site. This likely reflected the annual migration of moose to the Birch Mountains in early spring (Hauge and Keith 1979). Incidental observations of unmarked moose seen during fixed-wing flights also suggested this

Table 11. Summer food habits of wolves on the AOSERP study area as determined by scat analysis. Dates on which scats were collected are shown in parentheses. Totals include pup and adult scats collected at den or rendezvous sites, as well as fresh adult scats collected on adjacent cutlines.

Prey	% Occurrence among total food items from each location					
	Louise Creek Pack (Sept 1976)	Dover Lake Pack (Aug 1977)	Black Pack (Jun 1978)	Syncrude Pack (Jul 1978)	Muskeg River Pack (Jul 1977)	(Jul 1978)
Moose (adult)	36	19		12	36 (40)[c]	26
Moose (calf)	13	16	21	16	19 (21)	26
Caribou	3	1			1 (1)	
Total ungulate	52	36	21	28	56 (62)	54
Beaver[a]	40	50	52	48	13 (14)	31
Snowshoe hare	3	7	18	18	18 (20)	12
Other[b]	6	7	9	7	13 (4)	4
No. of scats	431	322	22	250	301 (262)	198
No. of items	519	414	33	289	390 (351)	224

[a] May include muskrat (*Ondatra zibethicus*).

[b] Includes wolf, vole, red squirrel, porcupine, unidentified fish and birds, and garbage.

[c] Excludes occurrence of wolf--one adult eaten by pups only.

Table 12. Food habits of wolves on the AOSERP and Swan Hills study areas as determined by scat analysis. All scats were of undetermined age and collected on trails or cutlines. Dates on which scats were collected are shown in parentheses.

	% Occurrence among total food items from each location				
	Dover Lake	Muskeg River area			Swan Hills
	(Jun-Sept 1977)	Fort Hills (Jun 1976)	Kearl Lake (Jun-Aug 1977)	Total	(Aug 1977)
Moose (adult)	30	47	29	37	66
Moose (calf)	2	11	14	13	9
Caribou	2				
Total ungulate	34	58	43	50	75
Beaver[a]	25	37	27	31	17
Snowshoe hare	30		14	8	4
Other[b]	12	6	16	11	4
No. of scats	48	37	37	74	77
No. of items	57	38	49	87	82

[a] May include muskrat.

[b] Includes vole, red squirrel, unidentified fish and bird.

seasonal change in availability of moose. Despite poorer visibility, nearly four times as many adult moose were seen per hour in the Birch Mountains during June to September (0.72) as during October to May (0.17).

Beaver lodge densities in fall, and moose densities in winter, were estimated on four areas where wolf scats were collected (Table 13). Beaver occurrence in wolf scats was directly related to population levels: low in Muskeg River scats and high in Dover Lake and Syncrude scats. Beaver densities were relatively high in the Swan Hills, but moose densities were up to nine times higher than on the AOSERP study area; this was reflected by a very high occurrence (75%) of moose in scats from the Swan Hills (Table 12).

Pimlott et al. (1969) and Voight et al (1976) found a 7 to 75% occurrence of beaver in items from scats collected in different areas and years. Such variation was attributed to differences in relative numbers and vulnerability of ungulates and beaver. Frenzel (1974) and Byman (1972) reported beaver occurrences of 16 to 21% among total prey items in areas of high ungulate density in northeastern Minnesota. Beaver comprised 13 to 16% of prey items in scats from Isle Royale during 1959-65 (Mech 1966; Shelton 1966), but by 1973 the beaver population had doubled and beaver comprised 51% of prey occurrences in scats (Peterson 1974).

Frequencies of identifiable prey remains in wolf scats do not necessarily reflect relative numbers consumed because of the great disparities in prey size and weight (Floyd et al. 1978). Diet may be determined more accurately by calculating relative numbers and biomass of prey, as demonstrated by Floyd et al. (1978). The food requirements of the Muskeg River Pack during 15 May to 15 October 1977 were estimated (Table 14) and the number and biomass (both relative and total) of prey consumed were determined (Table 15). Relative numbers and biomasses consumed were also calculated for the Muskeg River and Syncrude packs in the summer of 1978, the Dover Lake Pack in 1977, and the Louise Creek Pack in 1976 (Table 16). Adult moose

Tables 13. Densities of active beaver lodges in fall, and densities of moose and percent calves in winter, on the AOSERP and Swan Hills study areas. Year of survey shown in parentheses.[a]

Wolf pack area	Beaver lodges per km^2	Moose	
		No. per km^2	% Calves
Muskeg River	0.09 (1977)	0.22 (1977) 0.27 (1978)	19 (1977) 20 (1978)
Dover Lake	0.21 (1977)	0.25 (1978)	18 (1978)
Syncrude	0.38 (1975)	0.31 (1978)	19 (1978)
Swan Hills	0.22 (1976)	2.05 (1976)	24 (1976)

[a] Densities of active beaver lodges on the Muskeg River and Dover Lake areas were estimated from Gilbert (1978), on the Syncrude area from Penner (1976), and on the Swan Hills area from Todd (1976). Moose densities and percent calves on the Muskeg River, Dover Lake, and Syncrude areas were estimated from Hauge and Keith (1979), and on the Swan Hills area from G. Lynch (pers. comm.).

Table 14. Estimated minimum food requirements for the Muskeg River wolf pack during the summer of 1977 (15 May to 15 October).

Age of wolves	No. of wolves	Food requirements (kg/wolf/day)[a]	No. of days[b]	Calculated total food requirement (kg)
Adult	8	3.0	150	3600
Pup	5	1.5	90 (15 Jun-15 Sept)	675
	5	3.0	30 (16 Sept-15 Oct)	450
Total				4725

[a] From Mech (1970).

[b] Weaning date of pups was estimated to be 15 June; pups were considered to be adult size by mid-September.

Table 15. Sample calculation of the relative biomass and the number of major prey consumed by the Muskeg River wolf pack during the summer of 1977 (15 May to 15 October).

Data required for calculations, and specific calculations	Prey item			
	Moose		Beaver	Snowshoe hare
	Adult	Calf		
(A) Percent occurrence of prey in collected scats[a]	40	21	14	20
(B) Estimated mean weight (kg) of prey consumed when such prey is only item in a collectable scat[b]	8.56	2.20	0.63	0.41
(C) A X B (kg)	342.4	46.2	8.8	8.2
(D) Relative percent biomass consumed (A X B/ΣC)	84.4	11.3	2.2	2.0
(E) Estimated weight (kg) of prey consumed in summer (4725 x D)[c]	3 988	534	104	95
(F) Estimated mean consumable weight (kg) of individual prey in summer[d]	365	46	12.5	1.2
(G) Number of prey consumed in summer (F/E)	10.9	11.6	8.3	79.2

[a] From Table 11 (total without wolf).

[b] From Floyd et al. (1978).

[c] Minimum estimate of total summer food requirements from Table 14 was 4725 kg.

[d] Consumable weight of moose approximately 0.75 x whole weight (Peterson 1974). Consumable weight of beaver and snowshoe hare estimated to be 0.90 x whole weight. Whole weight estimates for moose are from Blood et al. (1967), W. Mytton (pers. comm.), and T. Hauge (pers. comm.); for beaver from F. Gilbert (pers. comm.); and for snowshoe hare from Keith and Windberg (1978).

Table 16. Number and biomass of prey (relative to adult moose) consumed by four wolf packs in the AOSERP study area during summer (15 May to 15 October). Initial calculations for the Muskeg River wolf pack shown in Table 15; calculations for other packs followed same format.

	Relative no. consumed by pack					Relative biomass consumed by pack				
	Muskeg River		Dover	Louise	Syncrude	Muskeg River		Dover	Louise	Syncrude
Prey	1977	1978	Lake	Creek		1977	1978	Lake	Creek	
Adult moose	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Calf moose	1.06	2.04	1.72	0.72	2.73	0.13	0.26	0.22	0.09	0.34
Beaver	0.76	2.56	5.67	2.08	8.60	0.03	0.09	0.19	0.07	0.29
Snowshoe hare	7.21	6.67	5.19	1.06	21.90	0.02	0.02	0.02	0.01	0.07

supplied by far the greatest biomass for all packs. Calf moose were taken from about one to three times as often as adults. Relative numbers of beaver and snowshoe hares taken varied greatly between packs.

4.10 IMPACT OF WOLVES ON THE MOOSE POPULATION

If the annual mortality of "adults" (yearling and older individuals) equals recruitment of new yearlings (previous spring's calves) in spring, a population will remain stationary. To estimate the potential impact of the Muskeg River Pack on the moose population, calculations were made of the number of adult moose alive in the pack's territory on 15 May 1977 and the total number killed by the pack during the ensuing year (Table 17).

From the density and population age ratio in late January 1977 (Hauge and Keith 1979), and the predation rates which were observed during January to March 1977 (Table 17), it is estimated that 269 yearling and older moose were alive on 15 May 1977. Alternatively, T. Hauge (pers. comm.) used population estimates and age ratios, in the winters of 1976-77 and 1977-78, and calf and adult mortality rates to obtain a mean estimate of 296 adult moose on 15 May 1977.

An estimate of total food requirements during summer, and thus also consumption (Table 14), was used with food-habits data to calculate the number of adult moose (11) consumed by the pack in the summer of 1977 (15 May to 15 October; Table 15). The number of adult moose (22) consumed in the winter of 1977-78 (15 October to 15 May) was determined from predation rates obtained during January to March 1978 (Table 17). In total, the Muskeg River Pack killed or scavenged 33 adult moose (11 + 22) from 15 May 1977 to 15 May 1978. The pack therefore consumed about 11 to 12% (33/296 to 33/269) of the adult cohort that year. Since recruitment of yearlings to the adult population in spring was 15 to 18% (Hauge and Keith 1979), wolf predation was apparently the major limiting factor on moose numbers in the Muskeg River area.

Table 17. Estimation of numbers of adult and new-yearling moose within the territory of the Muskeg River wolf pack on 15 May 1977, and the numbers and proportion of moose consumed by the pack over the following year.

Purpose of calculation	Data required for calculations, and specific calculations	Known or calculated values
Estimation of moose numbers within the pack territory on 30 January 1977	Annual pack territory size[a]	1289 km^2
	Estimated moose density within area on 30 January[b]	0.225/km^2
	Total number of moose within area (1289 x 0.225)	290
	Proportion of adults ($\geq$ 1.5 yr) in January population[b]	0.81
	Number of adults on area in January (0.81 x 290)	235
	Number of calves on area in January (0.19 x 290)	55
Estimation of moose numbers (excluding newborn calves) within the pack territory on 15 May 1977	Mean consumption rate by wolves in winter 1976-77	1 adult/9.2 days 1 calf/11.0 days
	Number of calves consumed between 30 January and 15 May (105 days/11.0 days per kill)	10
	Number of adults consumed between 30 January and 15 May (105 days/9.2 days per kill)	11
	Number of new yearlings alive on 15 May (55 - 10)	45
	Number of adults alive on 15 May (235 - 11)	224
	Total number of moose alive on 15 May (224 + 45)	269

Continued ...

Table 17. Concluded.

Purpose of calculation	Data required for calculations and specific calculations	Known or calculated values
Estimation of population of adult and yearling moose consumed by the pack from 15 May 1977 to 15 May 1978	Number of adults consumed from 15 May to 15 October[c]	11
	Consumption rate of wolves in winter 1977-78	1 adult/9.6 days
	Number of adults consumed from 15 October to 14 May (210 days/9.6 days per kill)	22
	Total number of adults consumed from 15 May 1977 to 14 May 1978 (11 + 22)	33
	Proportion of adult moose population consumed by wolves in the year starting 15 May 1977 (33/269)	0.12

[a] Includes all locations during 23 July 1977 to 15 May 1978.

[b] From Hauge and Keith (In press).

[c] From Table 15.

4.11 IMPACT OF DISTURBANCE

One of two large oil extraction plants on the AOSERP study area was under construction during the field studies. Construction activities were centred in a 50 km^2 clearing west of the Athabasca River and south of Fort MacKay. The main residence camp housed up to 4000 workers; its associated refuse dump, also located in the clearing, was just north of the plant site. A 40 man government camp and its dump lay immediately east of the clearing.

Six wolves were captured at the government camp during November 1977 to March 1978: three from the Syncrude Pack, one from the Black Pack, and two lone wolves. All three Syncrude wolves (two pups, one adult) were in good condition. But both loners (1.5 to 2.5 year old females) had at least three broken canines and were only the size and weight of pups. One lacked a toe and had a neck laceration caused by a snare; the other had a 7 cm^2 open wound on its hip. The captured female of the Black Pack apparently had mange and was without hair on one-third of her body; the other two pack members also appeared mangy when observed from the air.

The Syncrude Pack's territory encompassed the 50 km^2 clearing. That of the Black Pack abutted the Syncrude Pack's territory near the clearing's east side. Ranges of both radiocollared lone wolves were along the boundary between these two packs. The packs were located within 2 km of the clearing on 21 and 37% of relocations, and the lone wolves were often on it (12 to 18% of relocations; Table 18). Forty-two percent of pack and lone wolf relocations within 2 km of the clearing were also within 1 km of a dump.

The Syncrude Pack had a relatively smaller territory and higher wolf density than did other packs (Table 3). Densities near disturbed areas were also likely increased by the significantly greater proportion of lone wolves there (Table 19).

It appears that refuse near disturbed sites in the AOSERP study area, as on Ellesmere Island (Grace 1976), provided an alternate food source for wolves. The calculated kill rate of the Syncrude Pack was less than half that of the Muskeg River Pack (Table 10) despite

Table 18. Activity of radiocollared wolves that lived near or on development sites[a] within the AOSERP study area during November 1977 to April 1978.

	Pack or wolf name	Total no. of radio-locations	% of radio-locations within 2 km of develop-ment sites	% of locations in cleared area on development sites
Pack	Syncrude	67	37	9
	Black	56	21	0
Lone wolves	6168	40	80	15
	6171	41	80	12

[a] Development sites included active construction areas and dumps, heavily utilized roads and clearings, and residence camps.

Table 19. Number of wolf groups of various sizes observed from the ground during winter (November to March) 1976 to 1978 on the AOSERP study area.

	Size of group							Total no. of groups	Total no. of wolves	Mean group size
	1	2	3	4	5	6	7			
Disturbed areas[a]	10	3	0	0	1	1	0	15	27	1.8[b]
Undisturbed areas	69	3	4	5	3	7	29	120	440	3.7

[a] Observations in disturbed areas were made by project personnel on or near active construction areas and dumps, heavily utilized roads and clearings, and residence camps; observations in undisturbed areas were made by trappers on their winter traplines and reported in a questionnaire.

[b] Proportion of lone wolves significantly greater in disturbed areas ($X^2 = 8.25$, $p < 0.01$).

similar moose densities on the area during winter (Table 13). The observed size of the Syncrude Pack fluctuated greatly in winter, suggesting that the pack often split up and travelled in smaller groups. The Black Pack made no kills during a 40 day period in late winter, and apparently subsisted on remains of hunter-killed moose and refuse from dump sites.

Thus, it appears that disturbed areas containing refuse sites support higher densities of wolves than surrounding areas. Wolves in poor condition may be able to survive because of this alternate food source and packs may not have to kill moose as regularly.

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6. AOSERP RESEARCH REPORTS

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